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Review Article

Acceptance and Compliance with External Hip Protectors: A Systematic Review of the Literature

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Abstract. Hip fractures may be prevented by the use of external hip protectors, but compliance is often poor. Therefore, the objective of this study was to assess the determinants of compliance with hip protectors by systematically reviewing the literature. A literature search was performed in PubMed, Embase and the Cochrane Library. Primary acceptance with hip protectors ranged from 37% to 72% (median 68%); compliance varied between 20% and 92% (median 56%). However, in most studies it was not very clear how compliance was defined (e.g., average wearing time on active days and during waking hours, number of user-days per all available follow-up days, percentage falls with hip protector) and how it was measured. To provide more insight in the compliance percentages, the different methods of defining and measuring compliance were presented for the selected studies, when provided. Because of the heterogeneity in study design of the selected studies and the lack of quantitative data in most studies, results regarding the determinants of compliance could not be statistically pooled. Instead a qualitative summary of the determinants of compliance was given. The reasons most frequently mentioned for not wearing hip protectors, were: not being comfortable (too tight/poor fit); the extra effort (and time) needed to wear the device; urinary incontinence; and physical difficulties/illnesses. In conclusion, compliance is a very complex, but important issue in hip protector research and implementation. Based on the experiences of elderly people who wear the hip protectors, adjustments should be made to the protector and the underwear, while maintaining the force attenuation capacity. Furthermore, methods to improve the compliance should be developed, and their effectiveness tested.

Keywords: Acceptance; Compliance; Determinants; Elderly; Hip fracture; Hip protector

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Introduction

Hip fractures are a major health problem in the elderly. In The Netherlands more than 15 000 hip fractures occur every year [1]. The consequences of hip fractures can be severe. One year after hip fracture, the mortality of patients with a hip fracture is about 17–33% [2–4] and another 25–33% of the patients are severely disabled or cannot walk at all [3,5]. Furthermore, the costs of hip fractures are very high, especially due to hospital admission and nursing home stay [6,7].

While some drugs may prevent up to 50% of hip fractures in patients with established osteoporosis [8], attention has also been focused on nonpharmacologic interventions, such as the hip protector [9]. A hip protector is a shell of polypropylene, polyethylene or some other material, which is usually sewn or placed in pockets of special underwear. When a person falls on the hip, the hip protector will shunt away the energy towards the soft tissues around the hip and/or a part of the energy will be absorbed by the hip protector. Depending on the protector type, there may be differences in force attenuation capacity [10]. Hip protectors may be particularly important for elderly people who have osteoporosis and carry a high risk for falls.

The first large randomized clinical trial examining the effectiveness of external hip protectors on the incidence of hip fractures was published in 1993 [11]. The result of this study was promising: a relative risk of hip fractures of 0.44 (95% CI 0.21–0.94) was found in the intervention group as compared with the control group. However, compliance was poor: a substudy on falls showed that only 24% of the falls were protected.

To optimize the compliance of elderly persons with hip protectors, it is necessary to first identify factors influencing the compliance. Therefore, the objective of this study was to assess the determinants of compliance with hip protectors by systematically reviewing the available literature.

Methods

A literature search was performed in PubMed, Embase and the Cochrane Library from the start of these databases until June 2001 using the following keywords: compliance, prevention of hip fractures and hip protector. For each keyword synonyms were sought and combined using all fields: compliance (*compliance, adherence, receptivity, acceptability, feasibility*), prevention of hip fractures (*prevention, protection, protective clothing, protective device, hip fracture*) and hip protector (*hip protector, Safehip, Safety Pants, KPH, hip pad, hip fracture preventive system*). Furthermore, references of the selected articles were checked. (The precise search strategy is available on request.) The literature search was updated in May 2002 by adding the randomized clinical trials that were published since June 2001.

Two persons (W.D., P.L.), independently of each other, selected relevant titles and abstracts. The following inclusion criteria were used: (a) intervention: hip protector; (b) outcome measurements: compliance or primary acceptance; and (c) persons aged 65 years and over. When there was disagreement between the reviewers about the selection of an article, the article was judged again by both reviewers in full text and, when necessary, a consensus meeting was arranged. No restriction of year, language or publication type (review, full report, short report, abstract, etc.) was used. Only study protocols (without results) were excluded.

The median acceptance and compliance were calculated and the interquartile range was given. The results regarding the determinants of compliance could not be statistically pooled because of the heterogeneity in study design and the lack of quantitative data in most studies. Instead a qualitative summary of the literature is given.

Results

The first literature search was performed in September 2000. This resulted in 597 articles, of which 246 were found in PubMed, 273 were found in Embase and 78 were found in the Cochrane Library. After excluding the duplicate articles, 432 potentially eligible articles were left. Of these, nine titles/abstracts were selected by both reviewers; the reviewers disagreed about 23 titles/abstracts; and 22 titles/abstracts were unclear to both reviewers. After reading the 45 full-text articles (or abstracts/letters in the absence of a full-text publication) of the last two categories, in total 24 articles were selected for the review. In June 2001, the literature search was updated. This resulted in 83 new potentially eligible articles, of which five were selected. Reference tracking led to the inclusion of another four articles. The agreement between the two reviewers was good (Cohen's kappa = 0.72). Finally, in May 2002, the literature search was updated once more by adding three randomized clinical trials which had been published since June 2001.

Of the 36 selected articles, there were 14 studies which had acceptance or compliance with hip protectors as a primary outcome measurement. The most important characteristics of these studies are presented in Table 1. Four of these studies were of an exploratory nature [12–15] and consisted of focus groups (discussion groups according to certain questions) or interviews. In these studies, hip protectors were not worn by the participants; and in two of these studies the hip protector was not even shown to the participants [13,14]. Therefore, the results of these studies should be interpreted with caution. In another study, interviews were performed among purchasers of hip protectors [16]. It is difficult to compare the compliance in this study with the compliance in the other studies because purchasers are a very selected population. In the other studies, a prospective design was used [3,17–24]. Table 2 shows the acceptance and compliance and the determinants of compliance with wearing hip protectors in these studies.

Furthermore, eight randomized clinical trials examining the effectiveness of external hip protectors were selected [11;25–31], as well as one randomized clinical trial examining the influence of hip protectors on fear of falling and falls self-efficacy (belief in own ability to avoid falling) [32]. The results regarding the effectiveness of the hip protector are summarized in the Cochrane review of Parker et al. [9] and will not be described here. In one study, no acceptance or compliance percentages were reported at all [31]. The acceptance and compliance results of the other randomized clinical trials are presented in Table 3. Primary acceptance could be determined in only two randomized clinical trials, because in these studies the willingness to participate was assessed after randomization: 69% and 72% of the persons assigned to the hip protector group were willing to participate, respectively [25,28]. Compliance varied from 24% to 92%, with a median compliance of 57% (interquartile range 44–70%). However, compliance was defined in many different ways in the different studies, or sometimes not defined at all. When provided, the compliance definitions are presented in the Tables.

In the randomized clinical trials, which are presented in Table 3, some casual observations regarding the determinants of compliance were made. The following

Table 1. Characteristics of studies which examined the acceptance and the (determinants of) compliance with hip protectors

First author (year)	Design[a]	Study population	Type of hip protector (HP)	Mean age (years)	% female
Peer-reviewed articles					
Cameron (1994)	Focus groups: 5 with potential users; 1 with caregivers of demented patients	Elderly women hospitalized after fracture, joint replacement or falls and expected to return to the community (n=25); elderly persons with dementia living with their caregivers in the community (n=18)	Danish HP + locally made prototype	Median 83	100%
Myers (1995)	Interviews and medical records	Patients with hip fractures admitted to hospital (n=108); 94% community-dwelling	HP not shown to participants	Median 76	60%
Zimmer (1997)	Interviews	Community-dwelling (n=1406)	HP not shown to participants	76	58%
Butler (1998)	Focus groups: 2 with potential users; 4 with staff	Staff (n=29) and residents (n=15) from private hospitals and rest homes	Danish HP, Sydney HP, New Zealand HP	–	53%
Parkkari (1998)[b]	6-month prospective follow-up study; acceptance = the proportion of residents who were willing to use the device; compliance = the number of hours of wearing the protector; measured by the diary method; determinants of compliance assessed after 6 months	Ambulatory nursing home residents with a high risk of hip fracture (n=19)	KPH HP	82	75%
Villar (1998)	12-week prospective follow-up study (RCT); compliance was measured by randomly timed fortnightly visits	Rest home residents (I: n=101)	Safehip	Range (I) 64–96	100%
Birks (1999)	Postal survey	Purchasers of hip protectors: most purchasers were health professionals or relatives (n=45)	Hornsby HP, Safehip	80	87%
Suzuki (1999)[c]	6-month prospective follow-up study comparing 2 types of hip protectors	Community elderly aged $\geqslant$ 70 years with at least one fall in the preceding year (n=20)	Safehip, Safety Pants	–	100%
Yasumura (1999)[c]	4-week prospective follow-up study comparing 2 types of hip protectors	Nursing home residents (n=10)	Safety Pants, Danish HP	86	80%
Chan (2000)	9-month prospective follow-up study (RCT); surveys about perceptions of protectors; compliance = % falls with protector in place	Nursing home residents with a high risk of falls; 64.8% with dementia (I: n=40); surveys for staff (n=7) and residents (n=4)	HP from EVA foam	–	–
Hubacher (2001)[d]	10-month prospective follow-up study (RCT); compliance was checked on 20 days spread over follow-up; after 3, 6 and 10 months ''wearing comfort'', ''external visibility'' and ''usefulness'' were assessed	Nursing home residents with a high risk of falls (I: n=384)	HIPS	85	79%
Letters, abstracts and short reports					
Ross (1996)	2- to 6-month prospective follow-up study; compliance was measured by the diary method, unscheduled telephone calls or in-person visits and the presence or absence of protection during the fall. Goal: wearing HP for at least 80% of waking hours	Elderly persons (nursing home residents and community-dwelling) with a history of hip fracture, a diagnosis of Parkinson's disease or a history of cerebrovascular accident (n=129)	–	–	–
Becker (2000)	9-month prospective follow-up study examining hip protectors, education, counseling, training and information on environmental modifications in nursing homes	Nursing home residents (n=346); 76% could walk with help	2 types of HP, Not specified	–	–
Thompson (2000)	3-month prospective follow-up study; compliance assessed by interviews	Individuals aged 65 years and over, living at home but referred to domiciliary care with a high risk of falls (n=61)	Safehip	84	90%

RCT, randomized clinical trial; I, intervention group; HP, hip protector; mean age and % female were given for (potential) users not for their caregivers.
[a] Compliance definitions are presented only when provided.
[b] Two participants became bedridden and were replaced by residents of the same gender and similar age.
[c] Japanese: information from abstract and personal communication with the author.
[d] Randomized clinical trial, published since June 2001.

factors may influence the compliance negatively: musculoskeletal or cerebral disorders [11]; adverse effects, such as skin irritation or abrasion, swelling of the legs, bowel irritation [25,26,30]; hip protector experienced as too hot [29,33], uncomfortable in bed [26,29,33] and necessitating assistance in toileting [29,33]; being bedridden [30]. Other factors may influence the compliance positively: the good understanding and sufficient motivation of the institution staff [27] or staff commitment [26]; dementia [27]; hip protectors feeling warm, increasing the feeling of safety and decreasing the fear of falling [29,33]; positive attitude of the staff because the patients could be left to walk around more freely [29,33].

In two of the trials, an adherence nurse contacted patients when they were not adhering [26,32]. In the latter, approximately one third of the participants was visited because of insufficient adherence. After 4 months, only 8% of the participants were completely non-adherent. In this study, it was shown that hip

Table 2. Acceptance and compliance and determinants of (non-)compliance with hip protectors

First author (year)	Acceptance and compliance	Determinants of compliance	Determinants of non-compliance
Peer-reviewed articles			
Cameron (1994)	The majority would not use hip protectors	*Potential users*: underclothing of high quality *Reasons why a very small group was positive from the beginning*: fear of falling; recognition of the appliance's protective benefits *Caregivers of demented patients*: recognition that their relative was at risk	*Potential users*: hip fracture not relevant personally; concerns about comfort; appearance (length of the legs, not sexy, might be visible); accuracy of fit; cost; extra effort; unfamiliarity with protector *Concerns of caregivers of demented patients*: incontinence (three pairs insufficient); importance of the underwear being able to withstand washing and drying and still retain its shape and keep the protector pad in place; extra effort
Myers (1995)	70% of the patients were willing to wear a padded garment prescribed by a doctor; 55% were willing to wear an inflatable garment	*Factors associated with a positive response ($p < 0.05$)*: no previous hip fracture (OR = 6.9); an intrinsic cause of the fracture (OR = 11.4) *Factors associated with a positive response to an inflatable type ($p < 0.05$)*: being female (OR = 2.6); fracturing the hip away from home (OR = 8.7) *Important characteristics of protective garment*: effectiveness; fit; comfort; laundering; cost; not showing; looked well	
Zimmer (1997)	36% responded favorably to the possibility of wearing protective garment; this percentage was higher in certain subpopulations	*Persons who responded favorably (statistically significant):* females (OR = 1.39); middle education (U-shaped); home renovators (OR = 1.47); previous injury (OR = 2.30), mobility problems (OR = 1.07), unsatisfactory contacts (OR = 1.97)	
Butler (1998)	Principal nurse/managers would support the use; caregivers would supervise their residents; the majority of residents would wear hip protectors	*Staff and residents*: belief in effectiveness in preventing fracture; acceptable as a garment *Caregivers*: not concerned about the extra time *Residents*: comfort and appearance; men: desire for Y-front opening	*Principal nurse/managers*: concerned about the amount of extra time with toileting and dressing *Staff*: garment is too asexual for male residents; severe incontinence; laundering *Residents*: too tight and therefore uncomfortable
Parkkari (1998)	Acceptance: 63% Average wearing days (% of active days): 93%; average wearing time during waking hours: 91%; 2 persons wore protectors at night	Education and motivation of the staff	Not going to fall; protector pressing on operated hip; demented residents took the protectors off without verbal comment; too tight
Villar (1998)	Compliance: less than 1 week, 53%; between 1 and 12 weeks, 20%; 12 weeks (whole study period), 27%	Modification of the hip protector (participants with large size could not participate)	Discomfort; poor fit; physical difficulties; changed mind; illness; forgetfulness; temporary non-compliance because of heat wave
Birks (1999)	71% day or day and night; 9% some of the time; 18% not wearing them at all	Hip protectors of good quality; comfort; esthetics; effectiveness in preventing fracture; easy to wash and dry	Difficulties in wearing if suffering from incontinence or from weakness in upper limbs; discomfort at night; limited sizes available; cost
Suzuki (1999)	Compliance after 6 months: Safety Pants, 73%; Safehip, 44%	Compliers were significantly younger ($p < 0.05$) than drop-outs and had lower grip strength ($p < 0.01$)	*Early drop-out (after 1–2 weeks)*: difficulty in toileting: too small; muscle weakness *Later drop-out*: doctor's advice; too tight to wear in winter (because of using more underwear); site of operation interfering with protector; admission
Yasamura (1999)	Compliance (usually wearing) after 4 weeks: Safety Pants, 40%; Danish, 20%	Redesigning the hip protector for Japanese elderly may improve compliance; thorough explanation to elderly is needed	Difficult in wearing and delay in toilet; time-consuming; poor fit (too small or too tight)
Chan (2000)	Compliance: 50%		*Staff*: dementia; comfort; appearance; concerns about hygiene and inconvenience of putting them on *Residents*: comfort; perceived lack of personal risk
Hubacher (2001)	Acceptance: 68% Compliance (regular wearers) after 10 months: 36% Protector-wearers wore hip protectors for between 11 and 13 h on the 20 days	Persons who were physically restricted (OR = 2.39; 95% CI 1.38–4.12); who received disability compensation (OR = 2.11; 95% CI 1.14–3.91); who had a higher number of fall risk factors (three or more risk factors: OR = 2.02; 95% CI 1.10–3.71); and women (OR = 1.91; 95% CI 1.07–3.40) were more likely to accept the hip protector	*Reasons for stopping*: non-medical reasons (88%), health reasons (12%): aches or pains when wearing hip protector; tender spots or bruising when using a wheelchair *Significant differences between wearers and drop-outs ($p < 0.001$)*: experiencing hip protector as comfortable or useful; appearance unattractive
Abstracts, letters and short reports			
Ross (1996)	Compliance: 74% of 177 falls were protected; overall wearing time diaries, 78%; interview compliance, 81%	Hip protectors were welcomed by frail subjects with chronic disease and history of falls or osteoporosis	Alzheimer's disease
Becker (2000)	Acceptance, 37%; Compliance after 9 months, 81% (of 37%)		More help needed; extra incontinent episodes; at least 5 hip protectors needed when incontinent (extra cost); some protectors unusable after a few months of washing
Thompson (2000)	Number of high-risk subjects, 61; agreed to participate in study, 50; accepted protectors, 35 (70% of 50); compliant (on most days), 23 (66% of 35)	66% of fallers wore hip protectors on most days as compared with 27% of non-fallers ($p < 0.01$)	

Table 3. Randomized clinical trials in which compliance percentages were determined

First author (year)	Design[a]	Study population	Type of hip protector (HP)	Mean age (years)	% female	Acceptance and compliance percentages
Peer-reviewed articles						
Lauritzen (1993)[b]	11-month RCT; randomization by ward; compliance = % of falls protected; assessed in subgroup by a fall registration study	Nursing home residents aged ⩾ 70 years (n = 665; I: n = 247)	HP of polypropylene	–	68%	Compliance: 24% of falls were protected
Cameron (2000)	4-month RCT (as part of larger study); individual randomization; compliance assessed by visits	Community-dwellers at high risk of hip fracture (n = 131; I: n = 61)	Safehip	84	100%	Compliance: 92%; 8% was completely non-adherent
Kannus (2000)[c]	RCT; follow-up until 62nd hip fracture in control group; randomization by treatment unit; compliance = number of days protector was worn (with a minimum of 1 h) as % of all follow-up days; and % of falls protected; measured by a diary	Ambulatory elderly adults from community-based health care centers (1801 persons randomized; 1725 persons eligible according to inclusion criteria; I: n = 650)	KPH HP	81	77%	Acceptance: 69% were willing to participate in the HP group Mean degree of compliance: 48% 74% of falls were protected
Cameron (2001)[d]	18-month RCT; individual randomization; compliance was recorded on 4 occasions during the study; compliance = HP use during daytime, and % of falls protected; longitudinal compliance = % of follow-up time during which HP is worn during the day	Female residents of residential aged-care facilities, aged > 75 years, with 2 or more falls or 1 fall requiring hospital admission in the last 3 months (n = 174; I: n = 86)	Safehip	86	100%	Compliance after 12 and 18 months: 45–50% of surviving patients wore HP for at least half the day Mean longitudinal compliance: 57% 54% of falls were protected
Harada (2001)	RCT with average of 377 days follow-up; individual randomization; care staff checked daily whether and how often protectors were worn	Nursing home residents with ADL above the wheelchair level (n = 164; I: n = 88)	HP of polypropylene	83	100%	Compliance: 70% for complete 24 h wearing; 17% for incomplete wearing
Jensen (2002)[d]	RCT with 11-week intervention and 34-week follow-up; HP offered to 47 residents as part of a multifactorial intervention to reduce falls and fall-related injuries	Residential care residents of 65 years or older (402 persons randomized; I: n = 194)	–	Median 83	71%	Acceptance 72%
Abstracts, letters and short reports						
Heikinheimo (1996)	12-month RCT; 36 individuals were randomly chosen from 72; compliance = number of persons wearing HP at the end of the study	Nursing home residents with a previous fall who could walk independently (n = 72; I: n = 36)	Safety Pants	86	97%	Compliance: 68% was wearing HP at the end of the observation year 77% of falls protected
Ekman (1997)	11-month RCT; 1 of 2 nursing homes was randomly selected	Nursing home residents (n = 744; I: n = 302)	JOFA AB	84	–	Average compliance: 44% 27% of falls with protector in place

RCT, randomized clinical trial; I, intervention group; HP, hip protector; mean age and % women were given for participants from the intervention group.
[a] Compliance definitions are presented only, when provided.
[b] Persons who died were replaced by new persons. Compliance was assessed in a subgroup of which 61% was female.
[c] 219 persons dropped out from the intervention group and were replaced by 207 new persons.
[d] Randomized clinical trial, published since June 2001.

protectors improve falls self-efficacy. This can lead to an increase in physical activity and improved daily function and, therefore, to an improved compliance [34].

Furthermore, 11 reviews [35–45] and two abstracts [46,47] were selected. In a psychogeriatric nursing home, only one of 45 patients with a high risk for falls refused to wear hip protectors for a short time [35]. Caregivers did not experience the hip protectors as time-consuming. Furthermore, no pressure sores or problems with urinary incontinence material were observed. Patients who went to the toilet independently and could not manage the hip protector safely, were not given hip protectors.

In a running prospective cohort study in 500 orthopedic patients, changes were made to the design of the hip protector in order to improve the compliance [36]. During the first 9 months, 23% of the patients returned their hip protector (user rate 77%). According to the authors, these preliminary results show that easy handling appears to be important in improving the compliance. Dementia, however, may reduce the compliance [46]. In 1998, an abstract was published on the same study: after a follow-up of 1 year, primary acceptance was 57% and 46% stopped wearing hip protectors [47].

For a cost-effectiveness study, overall long-term compliance with wearing hip protectors was calculated [37]. When pooling the results of five studies [3,11,29,30,48], only 251 of 694 trial participants (36%) were wearing the hip protectors in the long term.

Finally, hip protectors can improve self-confidence and diminish self-restraint of physical activity, which is often caused by fear of falling [38]. In the other reviews that were selected, no new information regarding the determinants of compliance was found.

Discussion

Primary acceptance was low to moderate: it ranged from 37% to 72% in the studies in which hip protectors were actually given to participants [17,22–25,28,47]. Compliance varied between 20% and 92% [3,11,16—27,29,30,32,47]. The median acceptance and compliance were 68% (interquartile range 57–70%) and 56% (interquartile range 41–73%), respectively. However, in most studies it was not very clear how compliance was defined and how it was measured. If described, many different definitions were used, e.g., average wearing time on active days and during waking hours, number of user-days per all available follow-up days, percentage falls with hip protector, percentage participants who were wearing the hip protector on most days, percentage participants who were wearing the hip protector at a certain moment. Furthermore, the duration of the follow-up varied substantially; and in some studies, persons who dropped out were replaced by new subjects.

In one study, 53% of the participants stopped within 1 week and another 20% stopped between 1 and 12 weeks [3]. Apparently, most people stop wearing hip protectors soon after the start. Therefore, it seems advisable to use a try-out period or, in clinical studies, a run-in period. When using a run-in period in clinical studies, the compliance will probably be higher than without a run-in. However, the results can only be generalized to other people who have tried the hip protector during a run-in period and who were still wearing the hip protectors at the end of this period.

In two studies, different types of hip protectors were compared with regard to compliance [18,19]. In both studies a soft hip protector was compared with a hard type. Participants using the softer type were more compliant. However, both studies were very small. Furthermore, when choosing a certain hip protector not only compliance but also both the biomechanical and the clinical effectiveness should be taken into account.

Many different determinants for non-compliance were described. Most studies had an explorative nature. The determinants for non-compliance that were mentioned most frequently in the included studies were: not being comfortable (too tight/poor fit); the extra effort (and time) needed to wear the device; urinary incontinence and physical difficulties/illnesses. Because of the tightness of the underpants, some people experienced the hip protector as uncomfortable or having a poor fit. Furthermore, because of the same tightness, the hip protector was for some people difficult to remove. Therefore, some people needed more help with dressing or when going to the toilet. Also, persons who suffered from urinary incontinence needed more help when using the hip protector. They also needed more underpants. This can be a problem because of the high costs of the hip protector. Finally, physical difficulties (e.g., weakness in the upper limbs and protector pressing on operated hip) and illnesses (e.g., dementia) were reasons for non-compliance.

It seems very important to adjust the hip protector in such a way that it becomes more comfortable and easier to handle [46,47]. Furthermore, extra sizes should come available. However, the problem of the tightness of the underpants can probably not be solved completely, because some tightness is needed to keep the shells of the hip protector in place.

The hip protector is not an appropriate intervention for all elderly persons. When elderly people have difficulties in managing the hip protector, this is not only a factor influencing the compliance but may also increase the risk for hip fractures. In one case report, a hip fracture was reported in a woman with Alzheimer's disease who fell twice during one night while trying to go to the toilet [49]. The hip protector appeared to be around her knees during the falls. Another case, in which a 84-year-old woman sustained a proximal femoral fracture while correctly wearing a hip protector, concerned a person with vascular dementia and Parkinson's disease who tried to undress but was not able to undo the well-fitting hip protector. When trying to remove her underwear from underneath the hip protector, she lost her balance and fell [50]. According to Chel and Ooms [35], hip protectors should not be given to patients who go to the toilet independently but cannot put on and take off the hip protector safely.

In future research, it might be interesting to make a profile of people who show high adherence. This knowledge can possibly help in selecting people who are suitable for using hip protectors. Until now, only a few prospective studies have been carried out in which the hip protector was actually worn by the participants and in which the strength of the relationship was quantified. It was shown that compliers were younger ($p < 0.05$) and had lower grip strength ($p < 0.01$) than drop-outs [18]. Second, more drop-outs than wearers experienced the hip protector as uncomfortable ($p < 0.001$) and found the appearance of the hip protector unattractive ($p < 0.001$); and fewer drop-outs than wearers found the hip protector useful ($p < 0.001$) [24]. Third, fallers were more compliant than non-fallers ($p < 0.01$) [23]. This last finding is possibly one of the reasons why several trials have found effectiveness despite the fact that the compliance was low or moderate. It may be that the persons who have a higher risk of fracturing a hip, for example the fallers, show a higher compliance and use the protectors at a higher rate in fall-risk situations, for example, when going outside. This was supported by the study of Kannus et al. [25], in which 74% of the falls were protected while the overall compliance rate was 48%.

To make it possible to compare future studies, it is important to define acceptance and compliance consistently. Our proposal is to define acceptance as ''the

percentage of persons who agree to wear the hip protector''. The acceptance should be calculated by dividing all persons who agree to wear the hip protector by the total number of persons who were asked to wear the hip protector. User compliance can be assessed at certain time points, e.g., by unexpected visits, or continuously, e.g., by the diary method. Of the different methods (unannounced visits, announced visits, diary, telephone interviews, interviews, survey), unannounced visits seem the most valid method, because it can be checked whether the participant is actually wearing the hip protector. The diary method gives the most complete information, i.e., the total number of days and the number of hours per day the participant is wearing the hip protector. A disadvantage of this method is that it can influence the compliance and it is unclear how high the compliance will be when the participants are no longer using the diary. Furthermore, participants may forget to complete the diary or they may give socially desirable answers. To determine the compliance, it is preferable that three different calculations are made: (1) the proportion of persons who are compliant during waking hours (or the proportion of user-days per all available follow-up days); (2) the proportion of persons who are compliant during day and night time; (3) the proportion of falls with protectors in place.

In conclusion, acceptance and compliance are important issues in hip protector research. To enable comparability of future studies, acceptance and compliance should be defined more consistently, and the calculation method should be described clearly. It is important to examine in prospective trials which people are likely to adhere, and which people can handle the hip protector properly. Furthermore, based on the experiences of elderly people who wear the hip protectors and their caregivers, adjustments should be made to the protector and the underwear, so that elderly people are more willing to wear protectors. Furthermore, methods to improve the compliance should be developed, and their effectiveness tested.

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